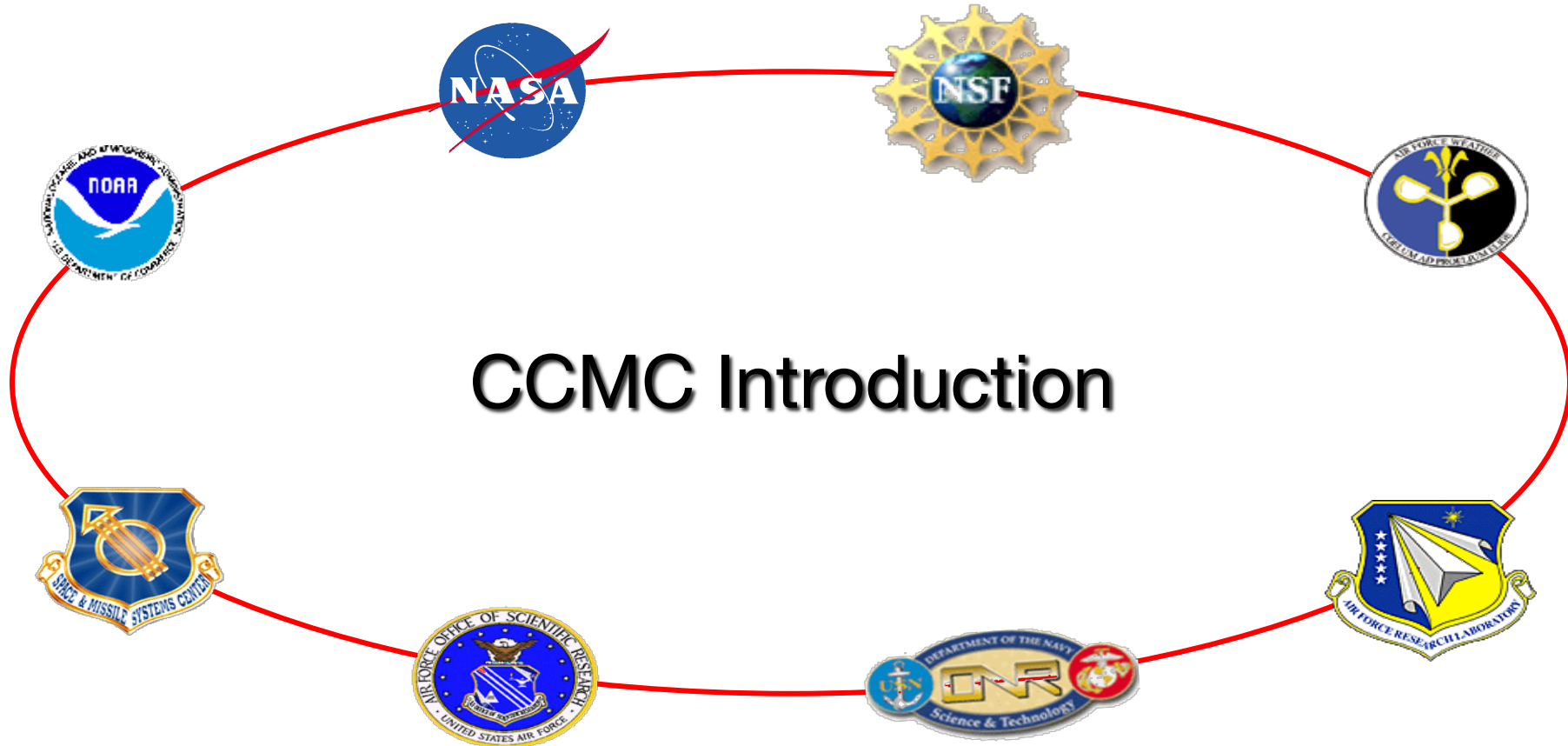


Community Coordinated Modeling Center



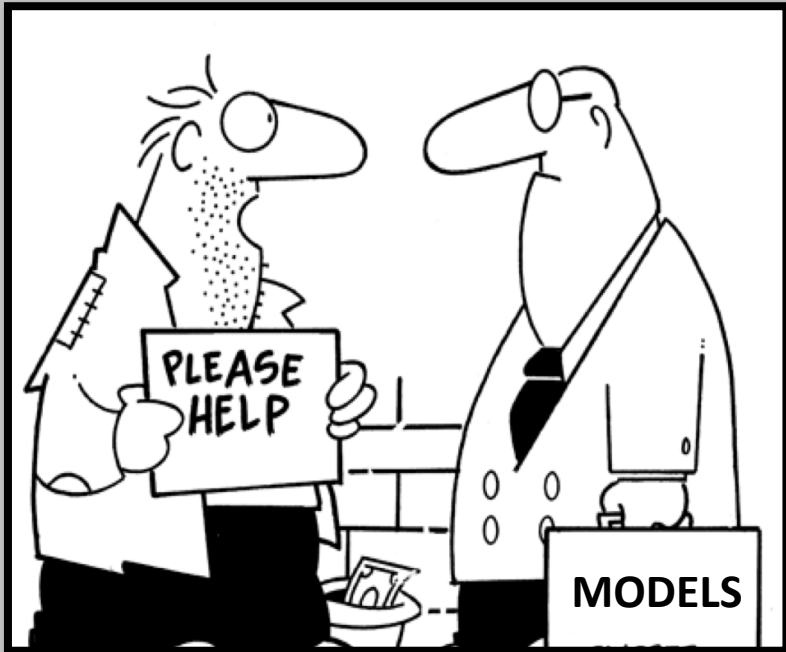
CCMC Introduction

M. Kuznetsova & CCMC Team

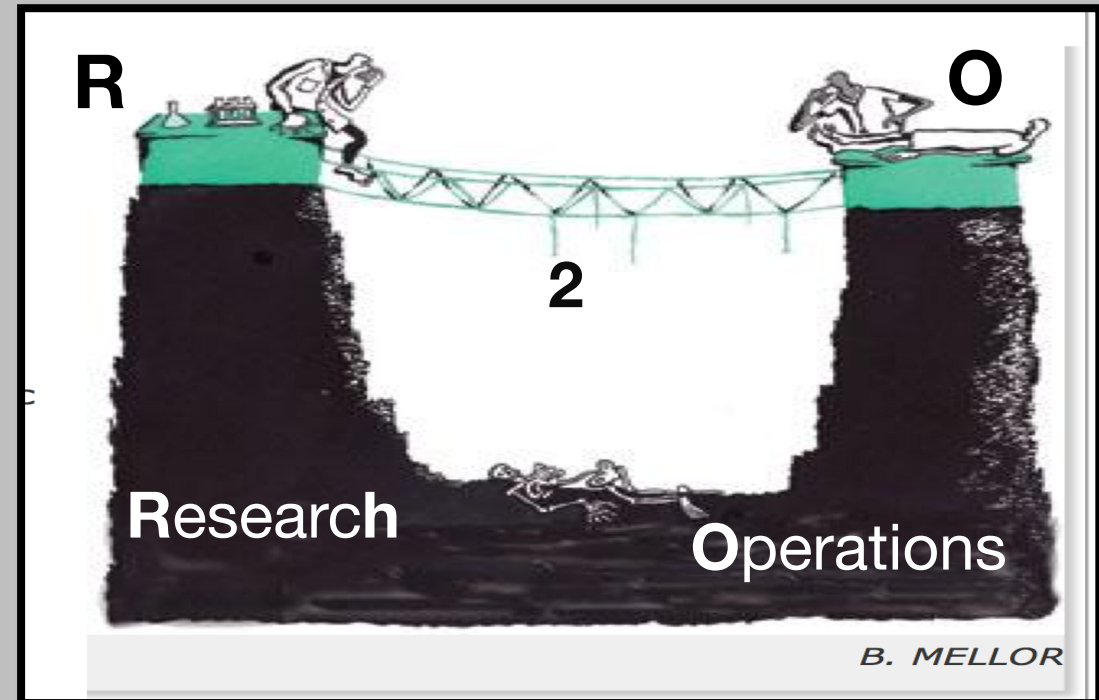
MODELS • DATA • TOOLS • DATABASES • SYSTEMS • SERVICES

Prior To CCMC

Models accessed and used by developers only.

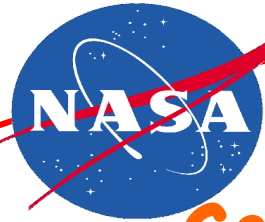


“Valley of Death” between **FUNDAMENTAL** space science research and **APPLICATIONS & SERVICES** to users affected by space environment





Established in 2000 as an essential element of the
National Space Weather Program

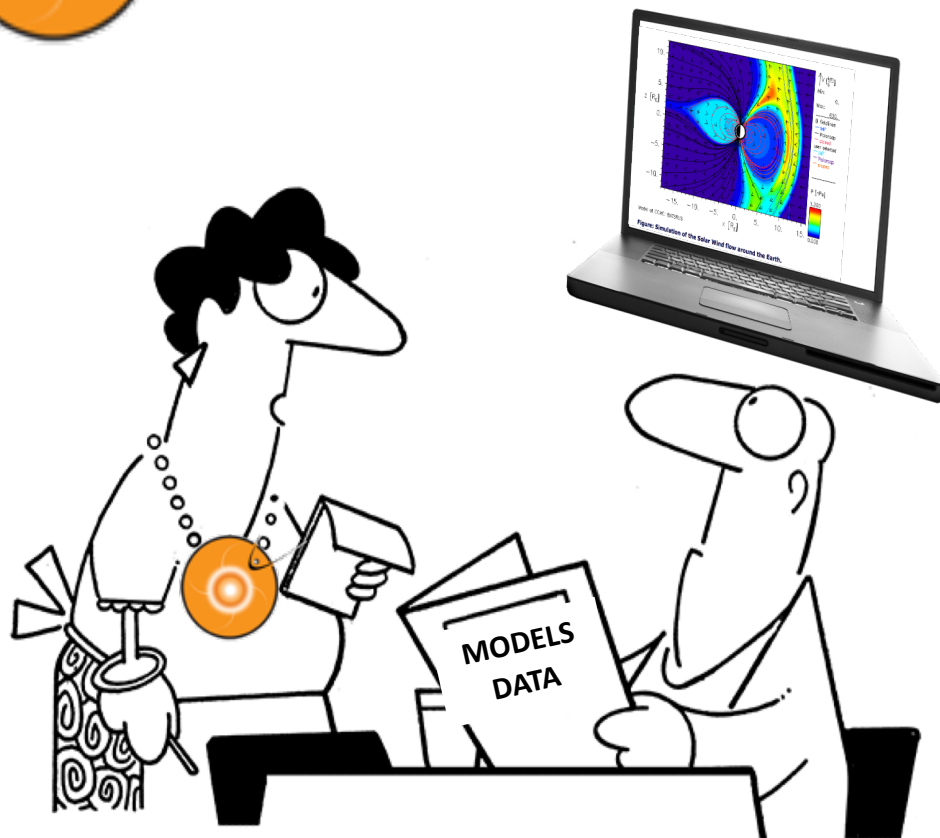


COMMUNITY COORDINATED MODELING CENTER

*A US multi-agency partnership to
support research and development
for next generation of space science &
space weather models*



CCMC is a Game Changing Solution



<http://ccmc.gsfc.nasa.gov>

*CCMC enabled
'Open model' policy*

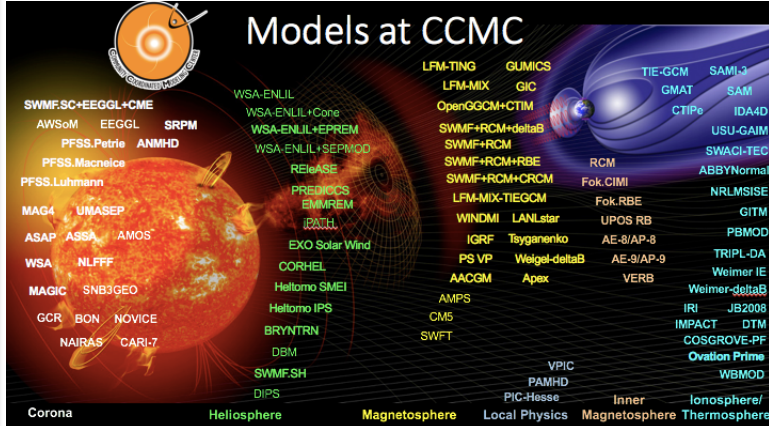




CCMC Assets & Services

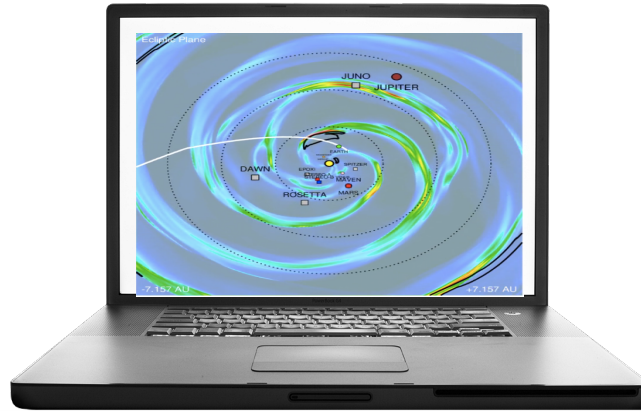
Models

Models at CCMC

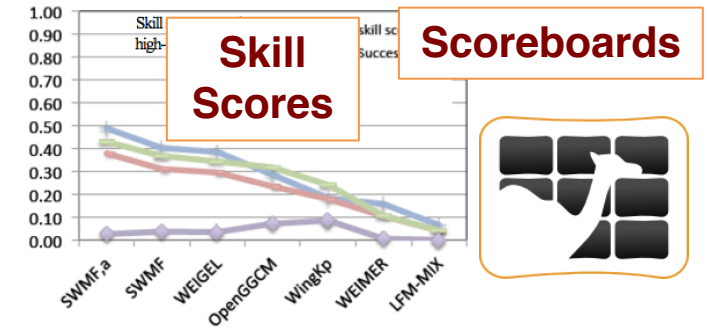


(expanding collection: > 100)

Simulation Services



Evaluations



Uncertainty Assessment

Applications
for space weather
research, monitoring,
forecasting



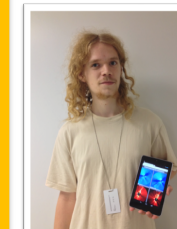
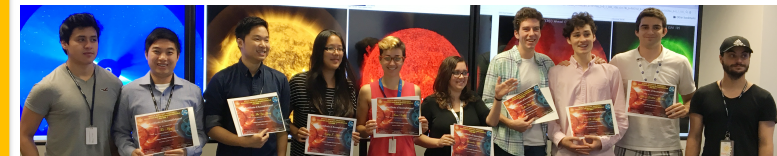
Space Weather Services

for NASA's missions



In-House Prototyping

Hands-on Education



CCMC Staff

CCMC STAFF at GSFC



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Solar



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Deputy Director



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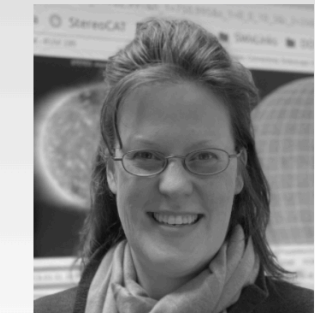
Mr. Richard Mullinix
Software



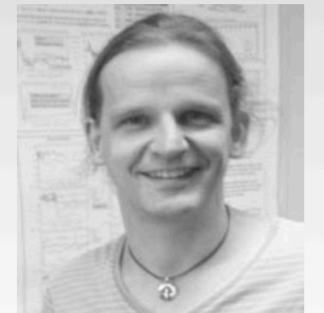
Mr. Elon Olsson
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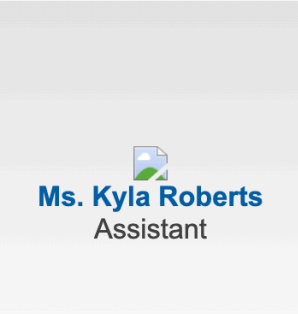
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Hardware Team Lead



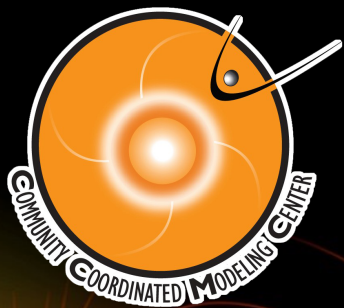
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Space Weather, Education



Ms. Chiu Weigand
Software Team Lead



Dr. Yihua Zheng
Space Weather, Education



Models at CCMC

SWMF.SC+EEGGL+CME

AWSOM EEGGL SRPM

PFSS.Petrie ANMHD

PFSS.Macneice

PFSS.Luhmann

MAG4 UMASEP

ASAP ASSA AMOS

WSA NLFFF

MAGIC SNB3GEO

GCR BON NOVICE

NAIRAS CARI-7

Corona

WSA-ENLIL

WSA-ENLIL+Cone

WSA-ENLIL+EPREM

WSA-ENLIL+SEPMOD

REleASE

PREDICCS

EMMREM

iPATH

EXO Solar Wind

CORHEL

Heltomo SMEI

Heltomo IPS

BRYNTRN

DBM

SWMF.SH

DIPS

Heliosphere

LFM-TING

LFM-MIX

OpenGGCM+CTIM

SWMF+RCM+deltaB

SWMF+RCM

SWMF+RCM+RBE

SWMF+RCM+CRCM

LFM-MIX-TIEGCM

WINDMI LANLstar

IGRF Tsyganenko

PS VP Weigel-deltaB

AACGM Apex

AMPS

CM5

SWFT

GUMICS

GIC

RCM

Fok.CIMI

Fok.RBE

UPOS RB

AE-8/AP-8

AE-9/AP-9

VERB

VPIC

PAMHD

PIC-Hesse

Local Physics

TIE-GCM

GMAT

CTIPe

SAMI-3

SAM

IDA4D

USU-GAIM

SWACI-TEC

ABBYNormal

NRLMSISE

GITM

PBMOD

TRIPL-DA

Weimer IE

Weimer-deltaB

IRI JB2008

IMPACT DTM

COSGROVE-PF

Ovation Prime

WBMOD

Inner

Magnetosphere

Ionosphere/

Thermosphere

CURRENT ACTIVITIES AND CHAIN OF EVENTS

- **Monitor models and activity 8am-8pm daily (performed by students under supervision)**
- **Notifications are sent out to users when thresholds are exceeded**
- **10am video and in-person “tag-up” meetings each work day**
- **“International” tag-ups with international/external partners**
- **Weekly Space Weather Reports**
- Flare (M5 or above) – SDO, GOES
- CME (Depending on the speed notifications will be send as fast as possible first with measurements and then with the simulation) – SOHO, STEREO A coronagraphs
- Solar Energetic Particle (if any) – SOHO, GOES
- CME arrival (in-situ data) – DSCOVR, ACE
- Geomagnetic storm (indicated by Kp index) – Global index
- Radiation belt electron flux enhancement - GOES

Challenges

- 1) Forecasting requires you to make assessments based only on what you know, not what you will know.
- 2) Some data are available immediately, some arrive later, some never arrive.
- 3) Some models and simulations are available quickly, and some take a while to run and produce results.
- 4) End users need different types of information. Some need it quickly, some need more detailed information and can receive it a little later.
- 5) For these reasons, we often iterate in our predictions, and provide updates.

CCMC community scoreboards

<https://ccmc.gsfc.nasa.gov/challenges/>



Leads: **Trinity College Dublin**
(S. Murray), **ROB** (J. Andries)



Leads: **BIRA-IASB** (M. Dierckxsens),
GSFC (I. Richardson),
UK Met Office (M. Marsh)



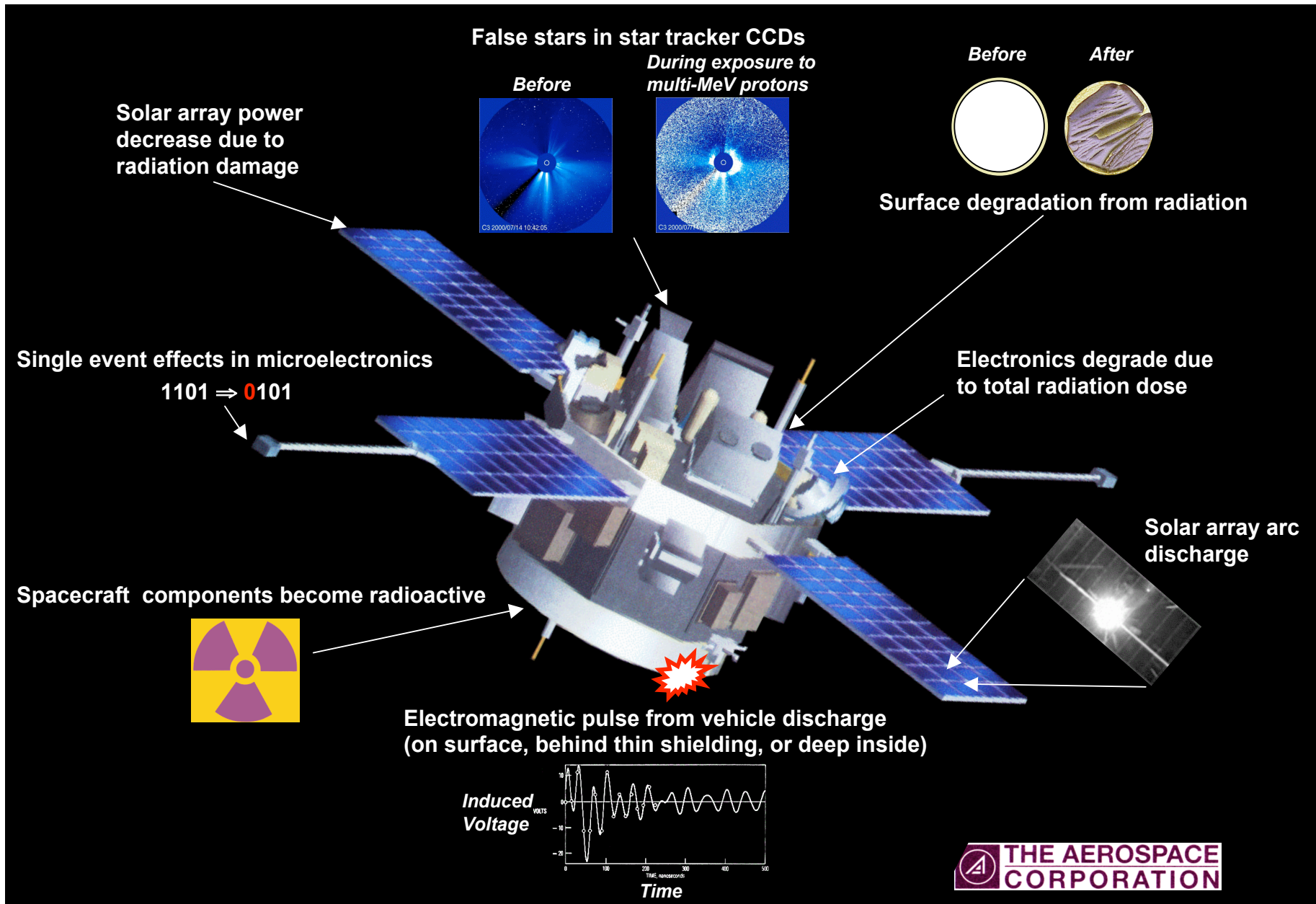
Leads: **CCMC**
(L. Mays),
UK Met Office



Leads: **PredSci** (P. Riley),
CCMC (L. Mays)

- Scoreboards collect forecast before event is observed
- Allow a consistent **real-time** comparison of various operational and research forecasts. Complementary to non-real time model assessments.

Visual Representation of Space Environment Hazards



CCMC Space Weather Forecasting

Anomaly Analysis Support for NASA Robotic Missions

- Anomaly Analysis are requested by NASA missions several times a month
- An assessment is prepared and sent to the mission team for their evaluation and decision.
- Sometimes face to face meetings are required when an evaluation board is conducted and the space weather environment is presented by our team.
- Critical decisions are made that take into account the space weather assessment.

- Some missions include:

MMS, ACE, STEREO, IBEX, Aqua, Aura, Terra, Landsat, VAP, GPM, Spitzer, DSCOVR, GOES, TDRSS, OSIRIS-Rex, SDO

We also work closely with the GSFC Space Asset Protection Program (SAPP) and we are part of the procedures for mission anomalies

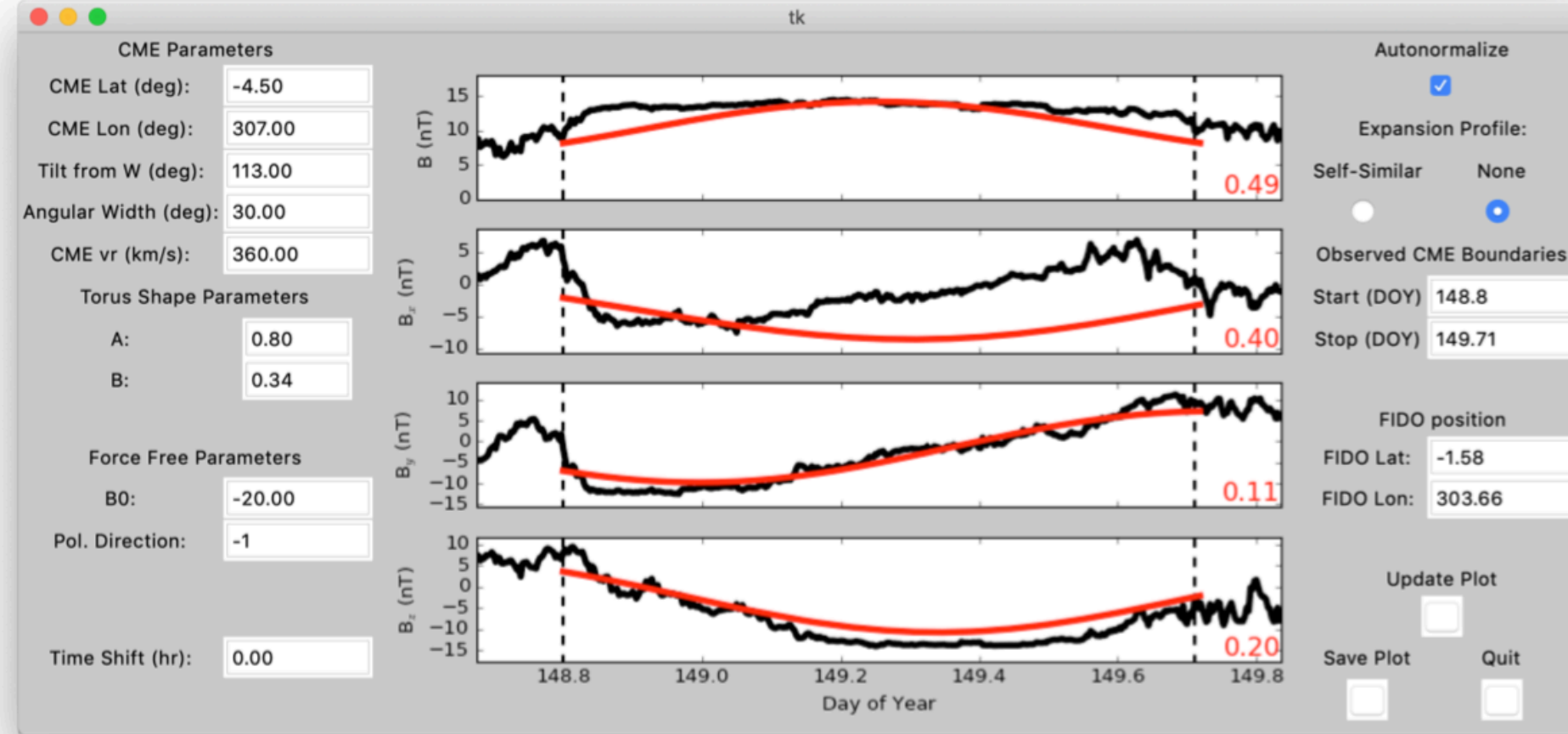
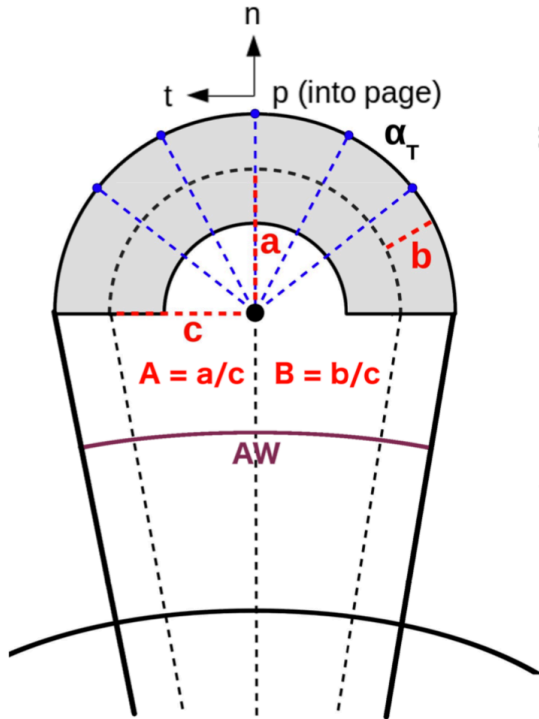
The support has been very important for the development of new missions, like GOES series.

During Shutdown:

Space weather forecasting services were critical and excepted. A mission had an anomaly that needed to be evaluated for an orbit departure and spacecraft health and safety.

ForeCAT In situ Data Observer (FIDO)(Christina Kay)

Torus Shape used to represent the CME flux rope

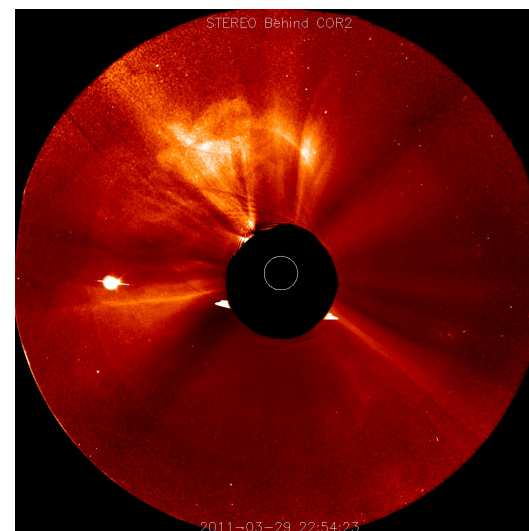
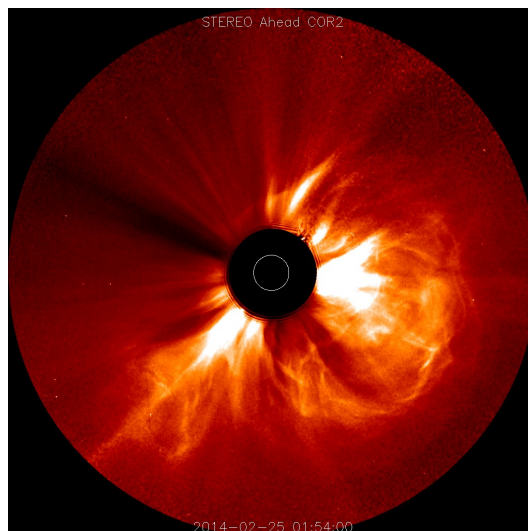
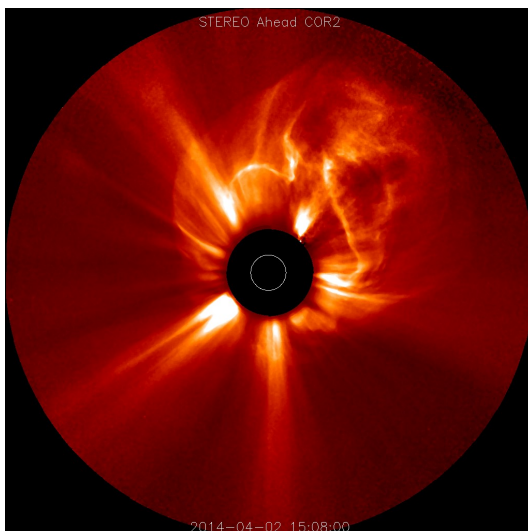


- **FIDO** is a tool that assumes a toroidal CME shape, propagates it past a synthetic spacecraft in three-dimensional space, and then applies a simple flux rope model to get the magnetic field as a function of time.
- Using observations from the solar wind monitors, FIDO compares the CME parameters predictions with the in-situ data and calculates scores (RMSE) for the specific CME moving in any location.
- This tool is being currently adapted to be used for real time analysis.



Online CME Analysis and Prediction Instructor (M. Crawford/ Kevin Nhan/Anna Chulaki)

- Project to invite citizen scientists to contribute to our space weather forecasting efforts
- It helps people understand our publicly available tools.
- Introduces the user to CCMC forecasting tools, including the data aggregator ISWA (featuring relevant image data from the NASA missions SOHO, SDO and STEREO as well as many other data products), the CME analysis applications, and the space weather recording and reporting database DONKI. It defines space weather concepts and trains the user to produce and record consistent analyses.
- Currently working on applying ML techniques to filter the users responses to understand which can be reliable and which users are learning faster.
- We are also working on possibly automate The system to obtain the parameters from the coronagraph images.



Implementing General Adversarial Networks (GAN) for Solar Proton Events (SPE) Data Augmentation (Juan Figueroa)

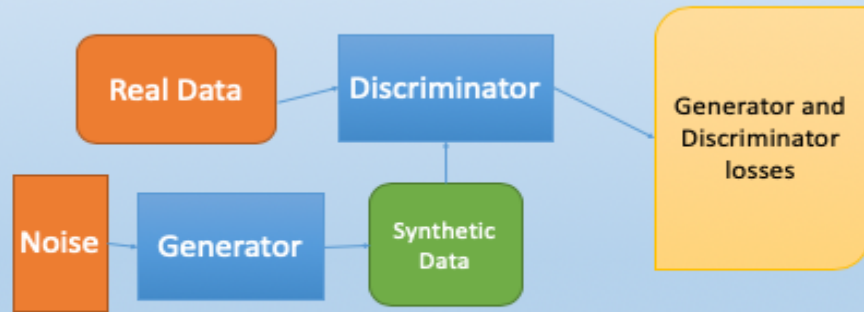
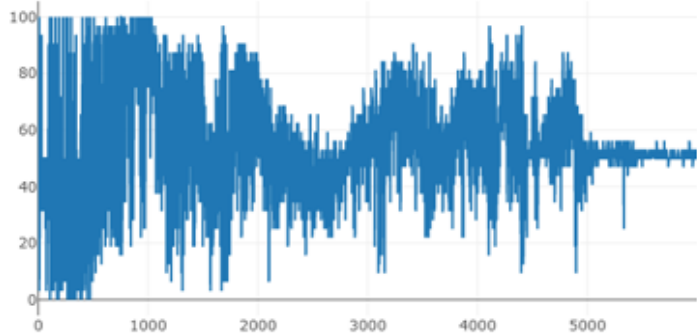
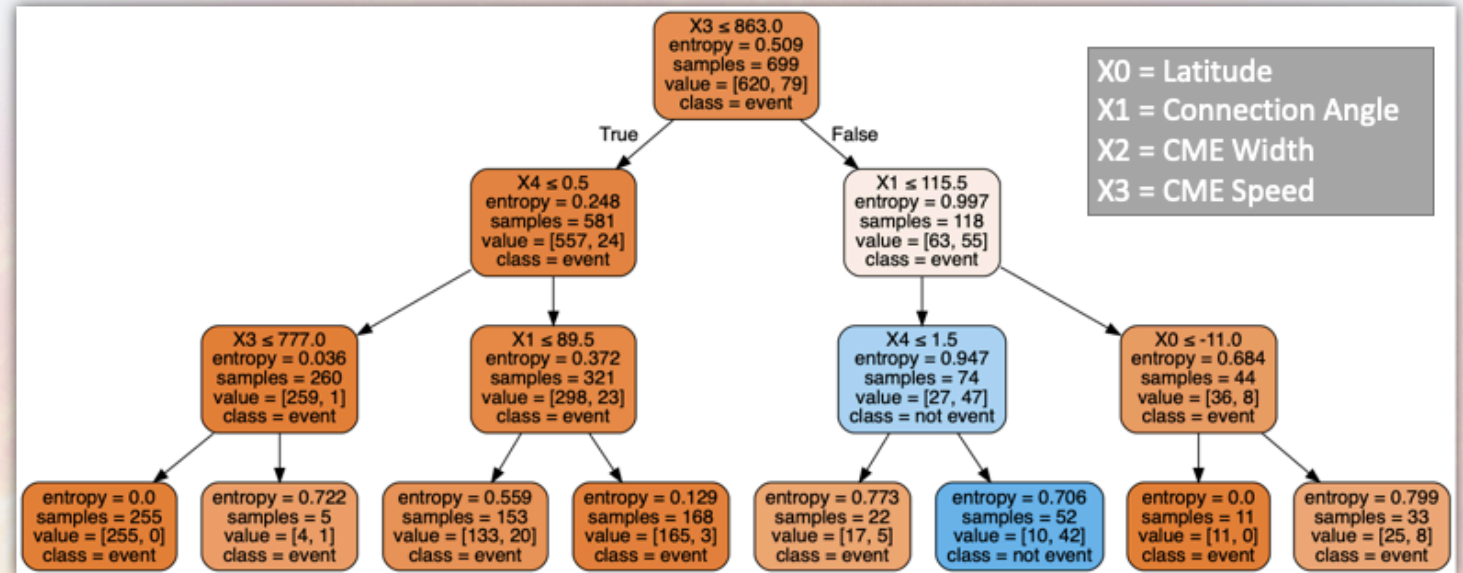


Fig. 1, Vanilla GAN Structure Diagram



GAN Discriminator Accuracy (Accuracy vs Epochs)

Results from our feature selection follow very well the parameters selected from Richardson et al. (2018) and the theory, especially CME Speeds. The parameters selected for augmentation include:



COSPAR 2020: International Space Weather Action Teams



ISWAT - International Space Weather Action Teams

Keywords



Join forces to advance space weather understanding and capabilities to alert and shield society!

HOME

JOIN ISWAT ▾

HOW WE WORK

NEWS, EVENTS, ACTIVITIES ▾

CONTACT US

Team title: Data archive preparation and implementation to advance Machine Learning activities for space weather forecasting in support of human exploration

[JOIN THE TEAM](#)

Team ID: O2-03

Team Leads:

Yaireska (Yari) Collado-Vega (NASA/GSFC, USA), yaireska.m.colladovega@nasa.gov

Shujia Zhou (Enter my own affiliationNASA GSFC/Science Systems and Applications, Inc. (SSAI)), shujia.zhou-1@nasa.gov

Juan Figueroa (Enter my own affiliationNASA GSFC/University of Puerto Rico), juan.figueroa17@upr.edu

[collapse class="open"]

Participants:

[/collapsed]

Keywords (activity type): Information Architecture

Data Utilization , Understanding, Modeling, Forecasting,

Keywords (impact): Human exploration

Moon to Mars Space Weather Analysis Office

- The Space Radiation Analysis Group from JSC and the Community Coordinated Modeling Center at GSFC are working in a collaboration to expand SRAG's space weather monitoring capabilities beyond LEO with the Integrated Solar Energetic Particle (Warning System) (ISEP) project.
- The ISEP project is focused on implementing mature space weather models that can support real-time operations and integration into scoreboard interfaces, which will allow for an ensemble approach to analyzing the space radiation environment. Scoreboards provide a variety of information to the user including projections of event probability, energetic proton peak flux, and flux time profile.
- A new office is being developed at GSFC to establish an interface of communications with SRAG that will employ NASA-specific operational model execution, data products, and displays. This office will leverage the capabilities developed by the ISEP project with an expandable foundation that will initially be applied to lunar missions but can later be applied to crewed missions to Mars.

Summary

- At CCMC we focus on providing critical space weather models and information for the scientific community.
- Our team provides accurate real-time experimental research forecasting of both large-scale and local space environments and their probable impacts for the current NASA missions.
- We perform experimental [research forecasts, notification, space weather analysis, and spacecraft anomaly resolution support](#).
- Anomaly resolution assessments have been critical for the support of current missions and for the development of future ones.
- We are also trying to develop or prototyping new capabilities including citizen science tools and ML techniques.
- The forecasting team and tools will be transitioned into a new office that will be operational (M2M Office).
- Results and lessons learned are communicated to the model developers and the wider space weather community.